J. Ethnobiol. 15(2):189–200 Winter 1995

IDENTIFICATION OF FIREWOOD SPECIES IN THE ARCHAEOLOGICAL RECORD OF THE PATAGONIAN STEPPE

ELENA ANCIBOR
Cátedra de Anatomía Vegetal
Facultad de Ciencias Exactas y Naturales
Ciudad Universitaria Pabellón 2
1428 Buenos Aires, Argentina

CECILIA PÉREZ DE MICOU
Sección Prehistoria
Instituto de Ciencias Antropológicas
Facultad de Filosofía y Letras
25 de Mayo 217 - 4° Piso
1002 Buenos Aires, Argentina

ABSTRACT—The microscopic study of nine species of local woody plants used as fuel in the Piedra Parada Valley (Province of Chubut, Argentina), is presented. The purpose of the paper is to give the main anatomical characteristics of their woods, in order to aid in their identification in the archaeological contexts of the Patagonian steepe.

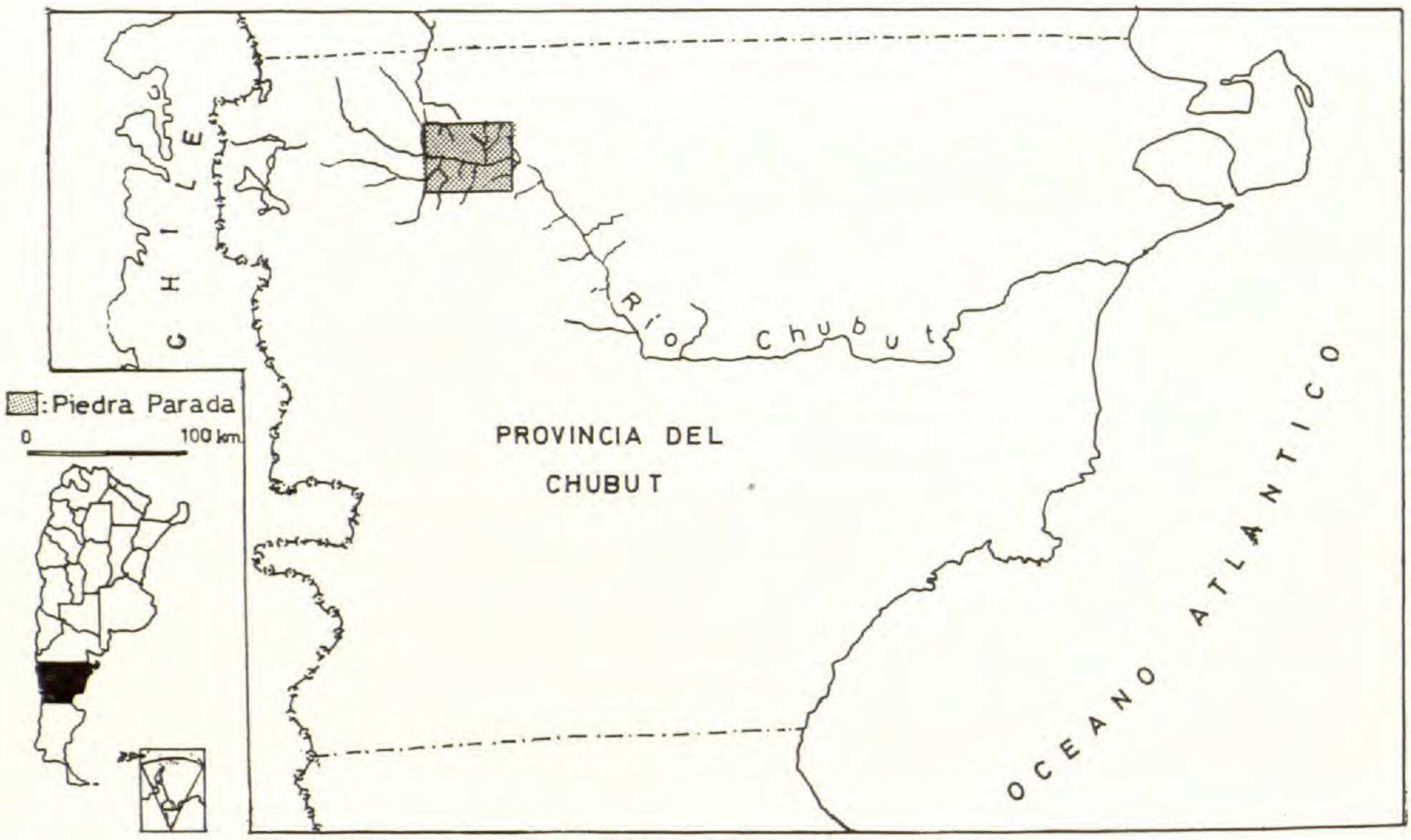
RESUMEN—Presentamos el estudio microscópico de nueve especies de plantas leñosas utilizadas como combustible en el Valle de Piedra Parada (Provincia de Chubut, Argentina). Su objetivo es dar a conocer los caracteres anatómicos principales de las leñas para facilitar su reconocimiento en los contextos arqueológicos de la estepa patagónica.

RÉSUMÉ—Nous présentons une étude microscopique de neuf spèces de plantes ligneuses employées comme combustible domestique par les habitants de la Vallée de Piedra Parada. Ce travail donne les charactères pricipaux de ces bois pour faciliter leur identification dans les contextes archéologiques de la Steppe Patagonique.

INTRODUCTION

This study is a part of an ethnoarchaeological research project conducted in the Piedra Parada Valley, Province of Chubut, Argentine Patagonia under the direction of Carlos Aschero (Aschero et al. 1983).[1]

Patagonia is located in the south of the Republic of Argentina, between latitudes 40°S and 55°S. From a broad, ecological point of view it can be considered a cool semi-desert. "Far from being uniform, the region exhibits quite a rich spectrum of vegetation types, from the real desert to shrub or grass steppe. No estimates have been made of the area actually covered by each one of the different



MAP 1.—The study area, Chubut Province, Argentina.

physiognomic units present, but a rough approximation could be: 45% shrub desert, 30% shrub-grass semi-desert, 20% grass steppe and 5% water surface and minor types like meadows, locally named "mallines cañadones," and "vegas" (Soriano 1983:423).

Although the current human population density in Patagonia is very low (0.6 people/km^2), human impact has become evident not only through the sheep industry but also through wood cutting, the oil industry, dam construction, and town and road building (Soriano 1983:245).

The Piedra Parada Valley is located in the northwest of the province of Chubut, between latitudes 42°20´-S and 43°00´-S, and longitudes 69°30´-W and 70°30´-W. The Chubut River crosses the province from west to east, and has a constant flow all year round. The climate is dry and cold (138 mm annual precipitation with temperatures between 17.9°C in January and 3°C in July); dominant winds are from the west. The native fauna is receding, but *Lama guanicoe, Rhea* sp., *Dusicyon griseus, Zaedius pichii,* and *Chaetophractus villosus* can still be seen (see Map 1).

The flora corresponds to the Patagonian Province, Western District (Soriano 1983:441). "The same general vegetation extends over plateaus, mountains, and the non-humid parts of valleys. It is a semi-desert in which the dominant plant form is tussock grass with linear, spiny leaves. Scattered among the grasses, shrubs less than 1 m high, frequently cushion-like, present themselves in a very wide range of density" (Soriano 1983:441).

This landscape does not, at first sight, present a large quantity of plants, nor a great variety of species, which could provide firewood. Nevertheless, in the archaeological excavations which one of us has been carrying out in the area, a large quantity of coals was recovered. These coals were found isolated as well as asso-

ciated with combustion features[2]. To find out what steppe shrubs could have been used for firewood, a contemporary ethnobotanical investigation was planned, based on the idea that the coal remains present in the archaeological contexts may provide information on a variety of functions carried out at the time of occupation: heating, lighting, drying, the cooking of food, smoking of meat, etc. The first results indicated that there is a relationship between 1) the shape adopted by the coal remains (flat spots, deep hearths, loose coals) and the activity which produced them, and 2) the type of firewood, activity carried out, and location of the activity in the site. This implies, not only that different firewoods were used for lighting, cooking, or heating, but also that the same function (cooking for example) may require different firewoods depending on the *locus* of the activity. This ethnobotanical information allowed us to state hypotheses about the functions of the combustion features which were found in the excavated sites (Pérez de Micou 1991a, 1991b).

Our main purpose in this paper is to offer the necessary reference material for identifying woody species present in the archaeological record, thus laying the groundwork for further interpretations regarding their possible uses. Taking into account that anatomical studies of these Patagonian shrub species are not available and that the information given here will be useful to archaeologists with a limited background in botany and plant anatomy, descriptions will be restricted to essential characteristics illustrated by photographs taken with an optical microscope.

MATERIALS AND METHODS

Materials.—The samples were collected in Languiñeo and Cushamen Departments, Province of Chubut, Argentina, with the advice of local inhabitants. Adults born here with a sustained residence in the area were selected as informants; persons permanently involved in rural activities were chosen. During our fieldwork we carried out open-ended interviews, direct observation, and participant observation of all the activities involving plant combustion. Notes were taken regarding the environments in which the informants located each species, the ways in which each type of firewood was obtained, and the use given to each according to its qualities. The scant population which is now scattered throughout the area has repeatedly and concordantly reported nine plant species which furnish firewood of different qualities. According to these qualities they are used for specific functions and in certain circumstances. We present the data as they were reported by the informants, who attributed special qualities to each firewood.

Herbarium materials are almost impossible to obtain in the case of firewoods, at least not from the same plants that provided the firewood samples. This is due to the transportation of the wood for variable distances after it is gathered.

Firewood varieties and their qualities.—The inhabitants of Piedra Parada distinguish environments in the area which are similar to those indicated in scientific papers. The alluvial plain adjacent to the Chubut River is called *"costa"*; this land constitutes the lowest floor of the Valley (400m elevation), with mild winters and natural protection for cattle. For these reasons the present inhabitants settle here during

the greater part of the year. The following species which supply firewood are reported for the *costa* of the Middle Chubut River:

Calafate (*Berberis buxifolia* Lam., Berberidaceae). The local inhabitants use the underground stems for fuel ("its firewood is buried") because the aerial stems are very thin. They dig around the plant and pull up the stems, or they strike them until they break. This hard wood is good because it burns slowly. In the area under study there is another species of *Berberis* which is also called *calafate* and used for firewood.

Algarrobillo (*Prosopis denudans* var. *patagonica* (Speg.) Burkhart., Leguminosae: Mimosoideae). It is found in low, warm areas. The underground stem is used for firewood ("its firewood is buried"), and this is obtained by digging. When the wood is dry, it breaks very easily; when burnt, it renders a bluish flame. The smoke causes headaches; therefore, it is not used in closed spaces. As a result of combustion it turns into ashes and not into coals.

Sauce criollo or *sauce de la costa* (*Salix humboldtiana* Willd., Salicaceae). This was once the most abundant species used for fuel by the Chubut River. It is currently only available in small remnant patches, having been replaced by (osiers) to which local inhabitants assign similar properties: "it burns very well." At present it is used in hearths both in the open air and in shelters.

Molle colorado (*Schinus marchandii.*, Anacardiaceae). It grows in sandy ground in warm areas. Its wood is valued because it is long-lasting and has high caloric value. Like *molle blanco*, it should not be used as the sole fuel but rather mixed with others of lower caloric value.

The informants find the best firewoods (now the scarcest) in the ravines (*cañadones*), which botanists recognize as a differentiated environment within the steppe. According to informants the ravines, which naturally link the *costa* with the higher land in the area, are well-travelled routes.

Barba de chivo (*Caesalpinia gilliessi* (Hook.) Benth., Leguminosae: Caesalpinoidea). Currently this species is very scarce. Its wood does not ignite easily but it is long-lasting and produces an intense flame.

Coliguay (*Colliguaya integerrima* Gill. et Hook., Euphorbiaceae). Its stem is underground, so it is necessary to dig in order to obtain firewood. The firewood has high caloric value, but when burnt it gives off "fat" which produces thick smoke, so it is not used in closed places. It turns quickly to ashes.

Calafate (*Berberis buxifolia* Lam., Berberidaceae). See above.

Typical steppe vegetation in the *campo alto* or high pampas, at a maximum elevation of 1000m. At present, flocks of sheep are brought here during the summer.

Monte guanaco (*Anarthrophyllum rigidum* Gill. ex Hook. et Arn., Leguminosae: Papilionaceae). It grows in warm areas. At present it is scarce because it has been used for firewood and for other purposes (for example to make posts for wire fences). Its firewood is easily lit and produces live coals which burn for a long time.

Molle blanco (*Schinus polygamus* (Cav.) Cabr., Anacardiaceae). It grows on the hills between 1000m and 1500m above sea level. Its wood is very hard to break. Like *molle colorado*, it should not be used as the sole fuel but rather mixed with others of lower caloric value.

Monte laguna (*Discaria* sp., Rhamnaceae). Nowadays plants of this species are very hard to find. It produces a very hard firewood with good combustion quality (easy to light, long-lasting, and of a high caloric value).

Leña de piedra (*Azorella monantha* Clos., Umbelliferae). This plant grows in cold highlands. It is difficult to ignite, and has to be mixed with dung to facilitate combustion. It is used only when nothing else is available. The plant is abundant in the coldest and most exposed environments, with persistent snow; therefore it is gathered in summer and is stored for winter. Because it is not a woody plant it has not been included in the table. Anatomical studies of a similar plant are available (Ancibor 1980).

Methods.—The samples of firewoods were cut into portions approximately 1 cm long. They were hydrated and softened by boiling them in water with drops of commerical detergent to facilitate hydration. The boiling time varied from 14 hours (e.g., *Salix humboldtiana*), to 56 hours (e.g., *Prosopis denudans*). The samples were oriented, and sections ± 20-25 μ thick were made with a sledge-microtome. Transverse (TS), longitudinal tangential (LtgS), and longitudinal radial (LrdS) sections were made. These three planes allow the appreciation of the characteristics of the woods studied (see Figures 1, 2, and 3).

The sections were treated with sodium-hypochlorite for five to ten minutes to eliminate their cellular content. They were carefully washed six times to eliminate the chlorine. The sections were dehydrated and stained to obtain a double coloration in a series of stains and ascendant alcohols (70° alcohol, 80° alcohol with safranin, 96° alcohol, 100° alcohol with fast green, 100° alcohol, and xylene). The sections were permanently mounted in artificial Canada balsam (D'Ambrogio 1986). This technique stains the lignified tissues (xylem) red and nonlignified tissues (parenchyma) blue.[4]

Observations.—The mounts were observed with an OM, and the three above-mentioned planes photographed for each specimen. The results of the observations were tabulated using the characters which were easily distinguishable in the photographs. The wood identification was made by comparison with the descriptions of Metcalfe and Chalk (1950), Tortorelli (1956), Cristiani (1962), Wheeler et al. (1989), and Castro (1994).

DISCUSSION

The visible and more useful characters for non-botanists who wish to study woods are vessels, their disposition and size. Compare, for example, Figure 3D with Figure 2D; the differences in vessel disposition are clear. The rays are also useful, mainly in tangential view: note their width, height, and cell composition, e.g. Figure 1C and Figure 2C. Features such as secretory canals in rays permit one to distinguish one species of *Schinus* from another, Figure 3F and 3I. Woods are readily classified if one has adequate comparative material and a minimum of practice and know-how (see Table 1).

From the point of view of archaeology, woods are extremely useful: they are an "open book," since woody materials are usually well preserved in archaeological

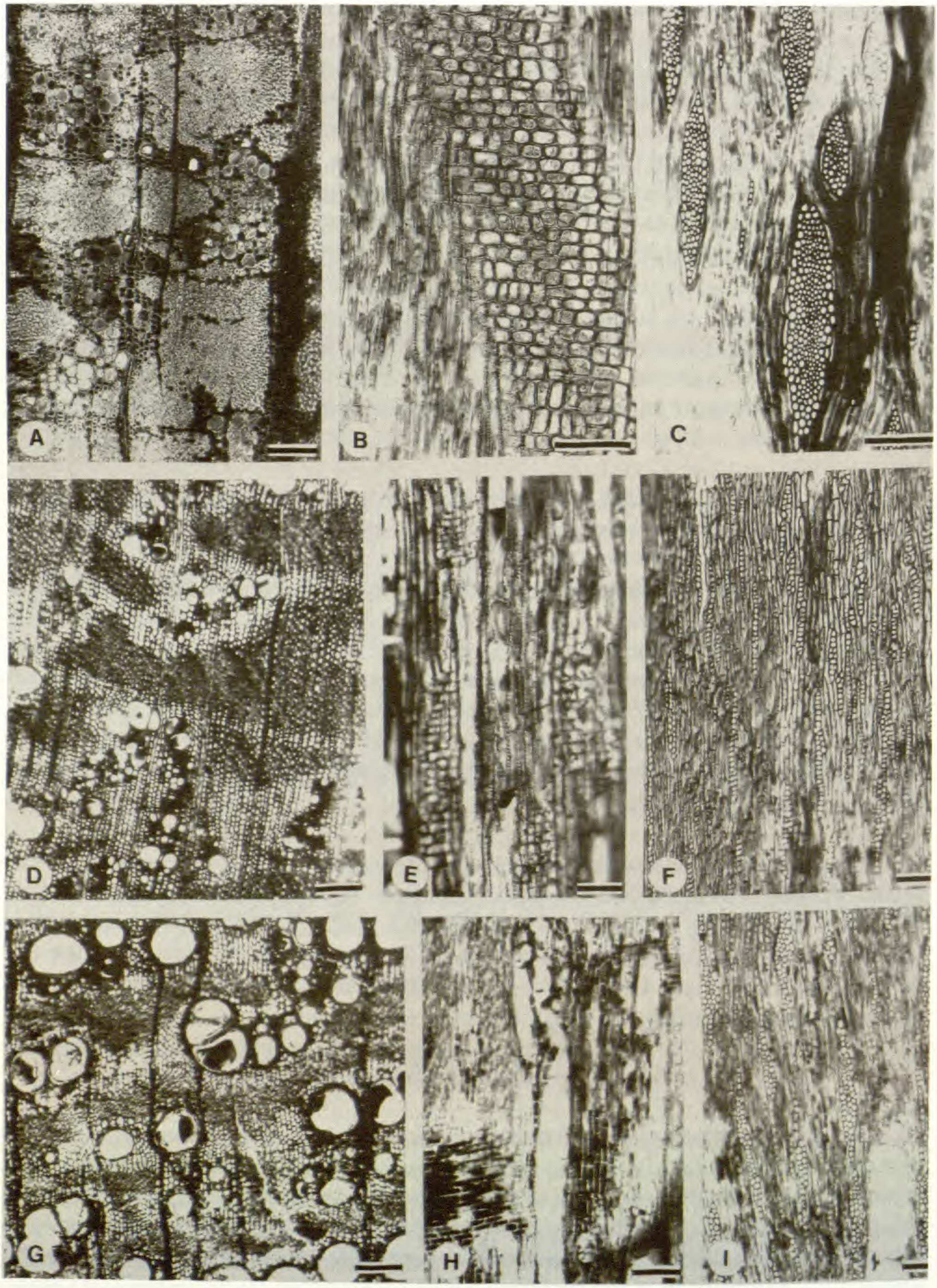


FIG. 1.—Wood sections observed with an optical microscope. A, D, G: Transverse sections; B, E, H: Longitudinal radial sections; C, F, I: Longitudinal tangential sections. A–C: *Anarthrophyllum rigidum*, ***monte guanaco;*** D–F: *Caesalpinia gilliesii*, ***barba de chivo;*** G–I: *Prosopis denudans var. patagonica*, ***algarrobillo.*** Scale lines = 100µ.

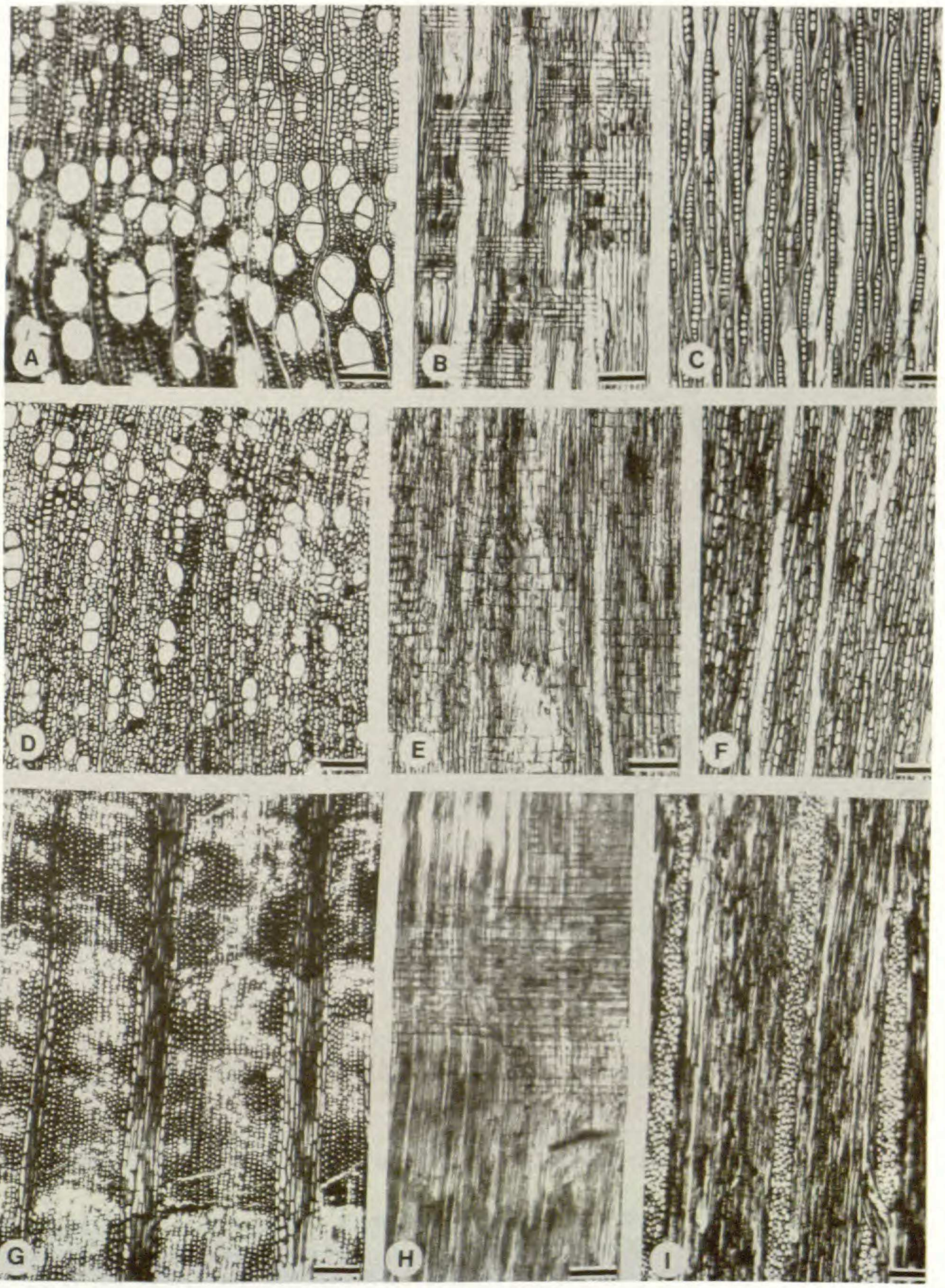


FIG. 2.—Wood sections observed with an optical microscope. A, D, G: Transverse sections; B, E, H: Longitudinal radial sections; C, F, I: Longitudinal tangential sections. A–C: *Salix humboldtiana,* ***sauce criollo;*** D–F: *Colliguaya integerrima,* ***coliguay;*** G–I: *Berberis buxifolia,* ***calafate.*** Scale lines = 100µ.

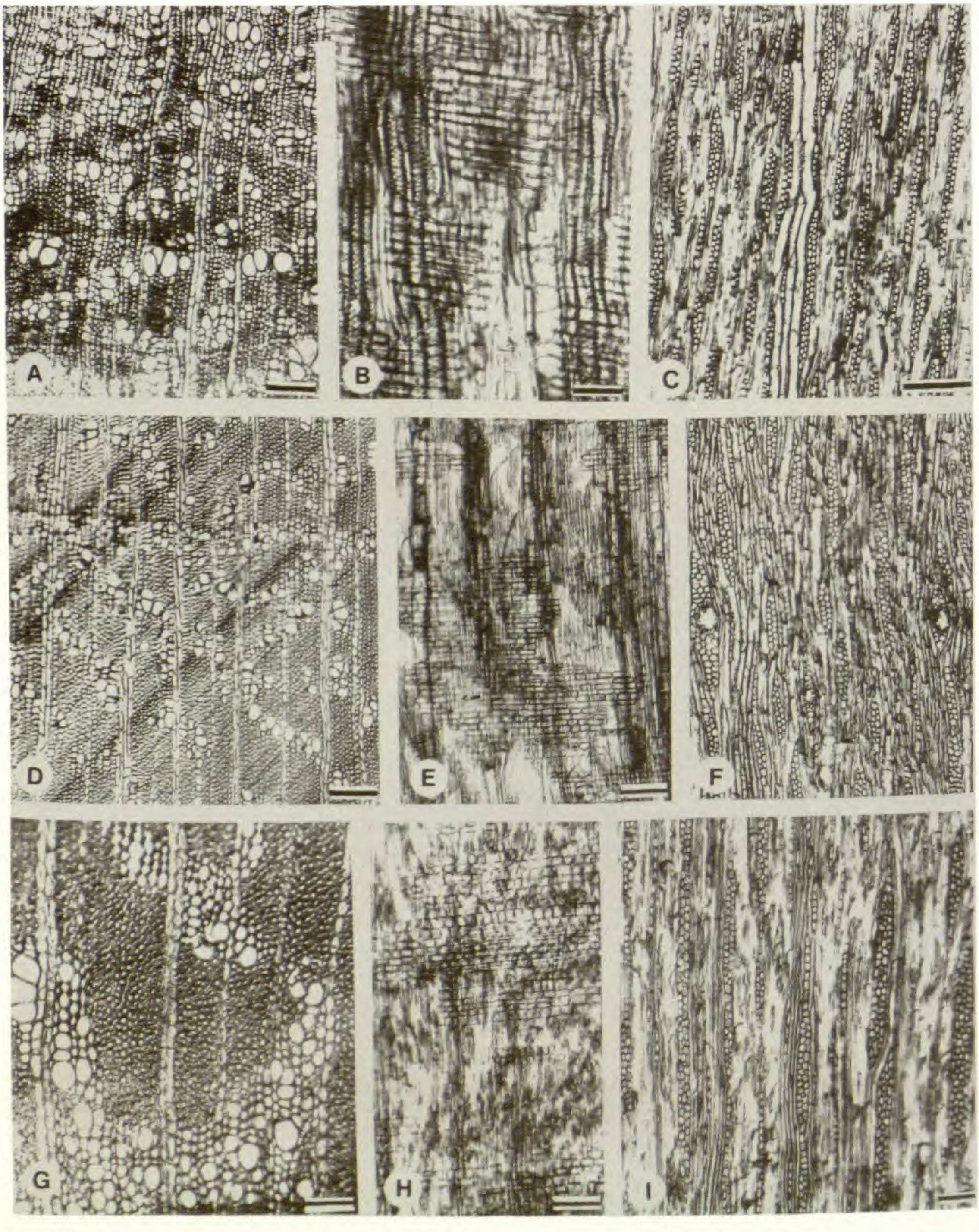


FIG. 3.—Wood sections observed with an optical microscope. A, D, G: Tangential sections; B, E, H: Longitudinal radial sections; C, F, I: Longitudinal tangential sections. A–C: *Schinus polygamus,* ***molle blanco;*** D–F: *Schinus marchandii,* ***molle colorado;*** G–I: *Discaria* sp., ***monte laguna.*** Scale lines = 100µ.

TABLE 1.—Firewood characteristics visible in microscopic sections: TS, LtgS and LrdS

Species	Figures	Porosity	Vessel disposition	Parenchyma	Fibers	Rays system	Rays type	Cell-inclusions
Berberis buxifolia (Berberidaceae) "calafate"	2 G,H,I	ring-porous	solitary, dendretic, in tangencial and radial bands	rare paratracheal vasicentric	aboundant thick-walled	homogenous 4-8 seriate	heterocellular	crystals of calcium-oxalate
Caesalpinea gillessi (Legum.: Caesalpinoi-deae) "barba de chivo"	1 D,E,F	diffuse-porous	solitary and short tangencial bands	paratracheal in confluent bands	aboundant thick-walled terminal	heterogeneous 1-2 seriate	heterocellular	cryst. calc.-oxal. tanins
Prosopis denudans var. *patagonica* "algarrobillo" (Legum.: Mimosoideae)	1 G,H,I	ring to semi ring-porous	solitary in short radial bands	paratracheal in confluent bands and aliform	aboundant thick-walled terminal	heterogeneous 1-3 seriate	heterocellular	cryst. calc.-oxal. tanins
Anarthro-phyllum rigidum (Legum.: Papi-lionoidea) "monte guanaco"	1 A,B,C	diffuse-porous	solitary in radial and tangencial bands	paratracheal in confluent bands	aboundant thick-walled terminal	heterogeneous 1-10 seriate	heterocellular	tanins
Discaria sp. (Ramnaceae) "monte laguna"	3 G,H,I	diffuse-porous	solitary and in short and long radial bands	paratracheal and inicial	aboundant thick-walled	heterogeneous 1-3-4 seriate	heterocellular an aggregate	—

TABLE 1.—Firewood characteristics visible in microscopic sections: TS, LtgS and LrdS (continued)

Species	Figures	Porosity	Vessel disposition	Parenchyma	Fibers	Rays system	Rays type	Cell-inclusions
Calliguaya intergerrima (Euphorbiaceae) "colliguay"	2 D,E,F	diffuse to semi ring-porous	solitary and short radial bands	apotracheal diffuse and rare paratracheal	thick-walled	1 homogeneous 1 seriate partially 2 seriate	heterocellular	—
Schinus polygamus (Anacardiaceae) "molle blanco"	3 A,B,C	diffuse-porous slightly dendritic	in clusters in tangencial and radial bands	scarcely paratracheal	aboundant thick-walled	heterogenous 1-2-4 seriate	heterocellular	cryst. calc.-oxal.
Schinus marchandii (Anacardiaceae) "molle colorado"	3 D,E,F	diffuse-porous slightly dendritic	solitary in radial and tangencial bands	scarcely paratracheal	scarce thick-walled	heterogeneous 1-5 seriate	heterocellular with resin ducts	tanins scarce
Salix humboldtiana (Salicaceae) "sauce criollo"	2 A,B,C	semi ring-porous	solitary and radial bands	apotracheal and rare	scarce thick-walled	1 homogeneous 1 seriate partially 2 seriate	heterocellular	—

sites. For this reason interdisciplinary cooperation in their study is important to document human life in dwellings from the past. It is also important for achaeologists to obtain a rudimentary knowledge of plant structures which may help them understand, date, and classify woods and other plant materials.

The identification of woods and coals present in the archaeological record opens a broad range of possibilities for 1) the interpretation of the activities carried out at the sites and 2) for our knowledge of the prehistoric Patagonian inhabitants' use of the environment.

Regarding the first aspect, the identification of woods used for fuel allows us to separate them from those destined for other functions. Even if only coals were studied, their identification would allow the differentiation of firewoods selected for their high caloric value and duration (destined for hearths for the cooking of food) from others burnt for other reasons (e.g., smoke signals).

Regarding the second aspect, the firewoods identified in the archaeological record clearly indicate the environmental zones which were utilized from the site. Based on this, firewood procurement territories can be outlined, firewood being considered a critical resource for the settlement of human groups in the past. In Piedra Parada there are prehistoric settlements in the three environments recognized by contemporary informants, and all three environments have species that provide firewood of different qualities. The identification of species through the study of the coals in each context will allow us to know if they correspond to those of the surrounding environment or if they come from environments which are far from the site. It will also allow us to establish possible connections between sites.

NOTES

[1] The project for the Recovery of the Archaeological Patrimony of the Province of Chubut has been carried out since February, 1979 in the Valley of Piedra Parada, directed by Carlos Aschero. The main objective of the project is the reconstruction of the different successive cultural systems in the north of Patagonia. This region was peopled around 5000 years ago by hunter-gatherer groups. This economy was maintained in a general way until the end of the nineteenth century, in which the Tehuelche and Araucano were decimated by European colonists. At present some descendants of these indigenous peoples remain who vaguely remember their ancestors' customs.

[2] The term "combustion features" is used to designate groups of coals of different shapes recovered in archaeological excavations. After analysis of the remains, these features can be called "hearths," "ovens," "hearth cleaning zones," etc.

[3] The informants who participated in this study are: Coca San Martín de Grenier, Nela San Martin, Irma Herrera de Oses (Paso del Sapo locality), Mila Fidalgo de Grenier and Juan Grenier (Sierra Negra), Elba Espinoza (Piedra Parada locality).

[4] Boiled and fixed materials, as well as dry firewood, are preserved in the wood collection of the Laboratory of Plant Anatomy, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina.

LITERATURE CITED

ANCIBOR, ELENA. 1980. Estudio anatómico de la vegetación de la Puna de Jujuy II. Anatomía de las plantas en cojín. Boletín de la Sociedad Argentina de Botánica 19(½). Buenos Aires.

ASCHERO, CARLOS, CECILIA PEREZ DE MICOU, MARIA ONETTO, CRISTINA BELLELLI, LIDIA NACUZZI and ALFREDO FISHER. 1983 Arqueología del Chubut. El Valle de Piedra Parada. Gobierno de la Provincia del Chubut, Rawson.

BOELCKE, OSVALDO. 1981. Plantas vasculares de la Argentina, natives y exóticas. Editorial Hemisferio Sur, Buenos Aires.

CASTRO, MARIA A. 1994. Maderas argentinas de Prosopis. Secretaría General de la Presidencia de la Nación, pp 101.

CRISTIANI, LUIS. 1962. Iconografía anatómica de maderas argentinas, secciones transversales por 15 aumentos. Revista del Instituto Municipal de Botánica II:87 181.

D'AMBROGIO DE ARGÜESO, ANA. 1986. Manual de técnicas en histología vegetal. Editorial Hemisferio Sur, Buenos Aires.

METCALFE, C.R. and L. CHALK. 1950. Anatomy of the Dicotyledons, Volumes I and II. Clarendon Press, Oxford.

PÉREZ DE MICOU, CECILIA. 1991a. Secuencias operativas de artefactos y ecofactos vegetales. Su visibilidad en el registro arqueológico. Actas del X Congreso Nacional de Arqueología Chilena, Santiago (October 1988), 1:201–245.

———. 1991b. Fuegos, fogones y señales. Una aproximación etnoarqueológica, a las estructuras de combustión en el Chubut Medio. Arqueología Revista de la Sección Prehistoria (Instituto de Ciencias Antropológicas), Facultad de Filosofía y Letras, Universidad de Buenos Aires, 1:125–150.

SORIANO, ALBERTO. 1983. Desert and semi-desert of Patagonia. Pp. 423–460 *in* Temperate Deserts and Semi-Deserts. N.E. West (editor).

TORTORELLI, LUCAS A. 1956. Maderas y bosques argentinos. Editorial ACME, Buenos Aires.

WHEELER, E. A., P. BAAS, and P. E. GASSON (editors). 1989. IAWA list of microscopic features for hardwood identification. International Association of Wood Anatomists Bulletin, new series, 10(3):219–332.